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(54) **An apparatus for the application of a conductive adhesive such as solder to a board with printed circuitry.**

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## Description

The invention relates to an apparatus for the application of molten solder to the side printed with circuitry of a board bearing electronic components by wave soldering, said apparatus comprising a hollow nozzle standing in a supply tank for the molten solder, and an obliquely inclined conveyor belt for one circuit board at a time, wherein the upper end of the hollow nozzle possesses two overflow edges arranged perpendicular to the direction of transportation for the formation of a wave, through the crest of which the side of the circuit board, previously moistened with a flux, is passed.

Soldering apparatus as such is known from DE-U1-8209572 which is provided with two nozzles, which are arranged one behind the other with respect to the direction of transport of the circuit boards to be processed. The purpose of the first nozzle is apply the adhesive medium or solder, generally a tin alloy, to the underside of the circuit board in a sufficient quantity to ensure covering of all the areas to be soldered, while the function of the second nozzle is to remove the surplus solder.

It is already known that the apparatus can be embodied with a single soldering nozzle, with which both functions can be achieved. However, with decreasing dimensions of the areas to be soldered, it is becoming increasingly difficult to achieve 100 % adhesion to all the areas using the conventional single-nozzle apparatus.

The present invention has for its aim to procure an apparatus with which a 100 % coverage of the areas to be soldered is in fact achieved.

The apparatus according to the invention is distinguished in that close to the leading overflow edge of said nozzle with respect to the transportation direction an adjustable damming means is arranged comprising a channel U-shaped in cross section and arranged perpendicular to the direction of transportation and having edges parallel to the overflow edges of said nozzle and pump means for temporary raising the level of said molten solder upwards out of the channel, such that the crest of the wave is shifted from the above nozzle toward said leading edge.

Owing to the damming means at the front of the shaft, an asymmetrical when viewed in vertical section wave crest is achieved, which brings in train the following unexpected advantages.

1. The underside of the circuit board is guided through a heightened crest over the commencement of the shaft, which effectuates an intensified flow of adhesive medium.
2. The gradually descending rear flank of the wave-crest results in a gradual decrease in surplus material, whereby short-circuit bridges are prevented.

According to a further development of the

apparatus, the invention proposes embodying the damming means in the form of a channel arranged perpendicular to the direction of transportation, the fluid adhesive medium being pumped upwards into said channel, the whole being arranged so that, together with the wave emerging from the shaft, the asymmetrical wave pattern is achieved.

In a particular embodiment, as the pumping means, a rotatably journalled driven roller with a non-round or round but eccentric transverse cross section is arranged in the longitudinal direction of the channel.

This embodiment offers the unexpected advantage that a small extra wave, whose frequency depends on the speed of rotation of the roller, is superimposed on the crest of the asymmetrical wave. Through this an agitated waveform is brought about, which is particularly advantageous for the soldering of very small components on the underside of the circuit board, since with a smooth wave-crest surface such components are difficult to reach, on account of the high surface tension of the adhesive medium. Owing to the fact that this takes place in the leading, downflow wave part, the portion of the wave which is situated above the shaft is hardly disturbed, whereby the smooth surface which is necessary for the gradual decrease in the surplus adhesive medium is maintained.

The invention will be further elucidated in the detailed description below of a number of embodiments.

In the drawing:

Figure 1 shows a perspective top view of a part of the apparatus which comprises the shaft in which adhesive medium is forced up,

Figure 2 shows a schematic vertical cross-section of the apparatus of figure 1,

Figures 3a, b and c each shows a vertical cross section corresponding to figure 2 of an alternative embodiment of a rotatable impeller, in the outflow part of the shaft,

Figure 4 shows a vertical cross section of a fifth embodiment, corresponding to figure 2.

In the sundry figures identical components are indicated with the same reference numbers.

The apparatus shown in figure 1 consists substantially of a tank 1, in which a shaft 2 is placed, such that the adhesive medium emerging from the shaft is collected in tank 1. This per se known construction is housed in a soldering apparatus which is provided with a conveyor belt 3, along which the circuit boards K to be treated are conducted above shaft 2. The conveyor belt passes moreover along a station for the application of a flux, and also a drying station, both being arranged before shaft 2 in the direction of transportation. These components are regarded as known and fall further outside the scope of the invention.

Shaft 2 consists substantially of a tower with a rectangular cross section, which is widened at the top

end when viewed in relation to the direction of transportation P1. Along the trailing edge of the tower is arranged a plate-like strip part which is fastened to the rear wall of the tower by means of screws 5, said strip part being extended downward in an apron part 6. The upper edge of strip part 4 forms a trailing overflow edge which extends perpendicular to the direction of transportation P1.

On the leading side of shaft 2 with respect to the direction of transportation P1 there is arranged a U-shaped channel 7, forming a part of a structure 8 which is fixed or optionally hingeable with respect to the shaft. The hingeable structure consists of two upright wall parts 9, which are pivotably coupled at 10 to the side wall of shaft 2. Between the side plates 9 a curved downflow plate 11 is arranged, which forms the leading overflow edge of channel 7. Finally, roller 12 is journaled in side plates 9, the roller being provided with bearing stubs 13 which are driven by driving means not shown.

Side plates 9 also have a lug 14, in which a threaded hole is located for accommodating a lead screw 15, which rests on a lug 16 on the side of shaft 2. By rotation of lead screw 15, the distance between lugs 14, 16 can be increased or decreased, so that plates 9 can hinge up and down around the pivot point 10, whereby the height of channel 7 and the thereto attached overflow plate 11 becomes adjustable in height with respect to shaft 2.

Finally it should be mentioned that a main pump 17 is arranged, in the known way, for the circulation of a conductive adhesive medium from tank 1 to shaft 2 and vice versa, by which means a wave can be realized at the top of shaft 2.

The surface of the wave is determined by the respective height of overflow edge 4 or of edge 18 between channel 7 and plate 11. The height is adjustable in the correct manner by means of overflow edge 4 and adjuster screws 15, or, respectively, by altering the throughput of main pump 17.

In this way there results a wave pattern with a symmetrical character by the conventional method, the wave crest lying approximately above the centre of shaft 2.

According to the invention, however, a pump means is driven in channel 7, said pump here taking the form of rolling body 12, which in transverse cross section displays a non-round or eccentric shape, for example a hexagon in figure 2. The rolling body is driven in the direction of arrow P2 by the driving of axle stubs 13, whereby in the channel a circulation of fluid adhesive medium comes about in the direction of arrow P2. This causes a surge of fluid adhesive medium above channel 7, so that the crest of the wave becomes displaced to a position above channel 7. This results in an asymmetric wave, such that during passage of a circuit board K along conveyor belt 3 (see figure 2) the crest of the wave can vigorously

inundate the underside of the circuit board. Owing to the fact that the distance between the leading overflow edge of strip 4 and channel 7 is enlarged, the surface of the rearward flank of the wave becomes gradually lower, which brings about the desired striking-off effect.

Owing to the non-round or eccentric cross section of rolling body 12, the part of the wave above channel 7 is also brought into vigorous turbulence, whereby the surface acquires an extra superimposed wave which yet further improves the vigorous inundation of the underside of circuit board K.

As soon as circuit board K has passed, the drive to the rolling body 12 may be stopped, whereby the wave surface drops to beneath the broken line 19 and the wave pattern consequently becomes symmetrical again.

On the other hand, it is possible to arrange the overflow edge of strip 4 at such a height that adhesive medium flows away only over channel 7.

This makes possible the option of protecting the surface against oxidation by supplying an insulating fluid material by means of nozzle pieces 20. By correct positioning of nozzles 20 over the surface above shaft 2, the fluid insulating material can be released on the most suitable places on adhesive medium to obtain a maximal protection against oxidation.

Nozzle pieces 20 are fed by a common supply line 21, which stands in connection with a supply tank 22. Supply tank 22 is linked to a pressure source 23, which is joined via a pressure regulator 24 and an electric valve 25.

Electric valve 25 is incorporated in the same control circuit as the drive motor of main pump 17, such that on starting up of main pump 17 valve 25 is actuated and liquid insulating material is spread via nozzle pieces 20 onto the surface of the adhesive medium in shaft 2.

Figures 3a to 3c illustrate variant embodiments of roller body 12. Thus figure 3a shows a roller body 12' with a substantially triangular transverse cross section, which is caused to rotate in the direction of arrow P3, that is to say, in the opposite sense to arrow P2 in figure 2, in a similar semi-circular channel. The surge of medium now takes place just in front of the leading edge of shaft 2, which may be desired in some embodiments.

Figure 3b shows a rolling body 12'' in the form of a fan, which is driven in the direction of arrow P2 and causes a surge as indicated by arrow P4.

Figure 3c shows a rolling body 12''' which is made with tooth-like projections 26 in the axial direction, which make the surge and/or the extra superimposed wave more vigorous.

The figures 3b and 3c show further a plate 30, being perforated with a suitable pattern and form of openings in order to distribute the flow of solder evenly over the width of the channel and so amelior-

ate the even raise of the level of the liquid. For an undisturbed inflow of liquid into the channel said plate 30 may be provided with an extension 31 reaching into said hollow shaft 2 to guiding the rasing fluid.

Figure 4 shows an embodiment in which the semi-circular channel is replaced by a rectangular cross-section U-shaped channel 7'. On the underside of the channel there discharges a supply line 27, which is fed by an adjustable pump 28. The pump receives fluid adhesive medium from tank 1 and ensures that during operation of main pump 17 extra medium is caused to surge into channel 7', so that a raising of the level and the asymmetric wave pattern are obtained. By splitting supply line 27 into a plurality of supply lines which are distributed over the length of channel 7', an irregular superimposed wave on the crest of the main wave can be obtained here too. For the rest, the operation of the apparatus according to figure 4 is the same as the embodiments described above.

#### Claims

1. An apparatus for the application of molten solder to the side printed with circuitry of a board bearing electronic components by wave soldering, said apparatus comprising a hollow nozzle (2) standing in a supply tank (1) for the molten solder, and an obliquely inclined conveyor belt (3) for one circuit board (K) at a time, wherein the upper end of the hollow nozzle (2) possesses two overflow edges arranged perpendicular to the direction of transportation for the formation of a wave, through the crest of which the side of the circuit board, previously moistened with a flux, is passed, characterized in that, close to the leading overflow edge of said nozzle (2) with respect to the transportation direction an adjustable damming means (7, 12, 27) is arranged comprising a channel (7) U-shaped in cross section and arranged perpendicular to the direction of transportation and having edges parallel to the overflow edges of said nozzle (2) and pump means (12, 27) for temporary raising the level of said molten solder upwards out of the channel (7), such that the crest of the wave is shifted from the above nozzle toward said leading edge.

2. An apparatus as claimed in claim 1, characterized in that the channel (7) is arranged on the outside of the nozzle (2).

3. An apparatus as claimed in claim 2, characterized in that the channel is adjustable in height with respect to the nozzle.

4. An apparatus as claimed in claims 1 to 3, characterized in that the channel shows in cross section a portion of a circle, and that the pump member is a rolling body (12), rotatably journaled in the longitudinal direction of the channel (7) and driven, with a non-round cross section.

5. An apparatus as claimed in claim 4, characterized in that the cross section is a hexagon.

6. An apparatus as claimed in claim 4, characterized in that the cross section is an eccentric.

7. An apparatus as claimed in one of the foregoing claims, wherein a means is arranged for the supplying of an insulating fluid material onto the wave surface, characterized in that one or more nozzle pieces (20) are connected to the supply means in order to deposit the material locally on the surface.

8. An apparatus as claimed in one of the foregoing claims, characterized in that above the channel a guiding perforated plate (30) is arranged.

9. An apparatus as claimed in claim 8, characterized in that said plate is provided with an extension (31) reaching into said hollow nozzle.

#### Revendications

1. Appareil pour l'application de soudure en fusion sur la face d'une carte à circuits imprimés portant des composants électroniques par soudage à la vague, ledit appareil comportant un conduit creux (2) se tenant dans un réservoir d'alimentation (1) pour la soudure en fusion, et une courroie de convoyage inclinée obliquement (3) pour transporter des cartes à circuits (K), une à la fois, dans lequel l'extrémité supérieure du conduit creux (2) possède deux bords de débordement placés perpendiculairement à la direction du transport pour la formation d'une vague, au travers de la crête de laquelle la face de la carte à circuits, préalablement enduite d'un flux, est passée, caractérisé en ce que, près du bord d'attaque de débordement dudit conduit (2), en tenant compte du sens du transport, un moyen réglable d'endiguement (7, 12, 27) est aménagé comportant une goulotte (7) dont la section transversale est en forme de U et qui est disposée perpendiculairement au sens du transport et ayant des bords parallèles aux bords de débordement dudit conduit (2) et en ce qu'il comporte des moyens de pompage (12, 27) pour élever temporairement le niveau de ladite soudure en fusion vers le haut de la goulotte (7), de sorte que la crête de la vague est déplacée depuis ledit conduit vers ledit bord d'attaque.

2. Appareil selon la revendication 1, caractérisé en ce que la goulotte (7) est disposée à l'extérieur du conduit creux (2).

3. Appareil selon la revendication 2, caractérisé en ce que la goulotte est réglable en hauteur par rapport au conduit.

4. Appareil selon l'une des revendications 1 à 3, caractérisé en ce que la goulotte présente une section transversale en portion de cercle, et que l'élément de pompage est un corps roulant (12) avec une section transversale non circulaire, dont la rotation est commandée et maintenue dans la direction longitudi-

nale de la goulotte (7).

5. Appareil selon la revendication 4, caractérisé en ce que la section transversale est un hexagone.

6. Appareil selon la revendication 4, caractérisé en ce que la section transversale est un excentrique.

7. Appareil selon l'une quelconque des revendications précédentes, dans lequel un moyen est aménagé pour l'approvisionnement d'un matériau fluide isolant sur la surface de la vague, caractérisé en ce qu'une ou plusieurs buses (20) sont reliées au moyen d'approvisionnement afin de déposer le matériau localement sur la surface.

8. Appareil selon l'une des revendications précédentes, caractérisé en ce que au-dessus de ladite goulotte, une plaque perforée de guidage (30) est installée.

9. Appareil selon la revendication 8, caractérisé en ce ladite plaque est prévue avec une extension (31) aboutissant dans ledit conduit creux.

#### Patentansprüche

1. Vorrichtung zum Aufbringen von geschmolzenem Lot auf die mit einer Schaltung bedruckte Seite einer elektronischen Bauteile tragenden Leiterplatte durch Schwall-Löten, wobei die Vorrichtung eine in einem Vorratstank 1 für das geschmolzene Lot stehende hohle Düse 2 und ein schräg geneigtes Förderband 3 zur Einzelzuführung einer Leiterplatte K umfaßt, wobei das obere Ende der hohlen Düse 2 zwei Überlaufkanten aufweist, die senkrecht zur Transportrichtung für die Bildung eines Schwall angeordnet sind, durch dessen Kamm die vorher mit einem Flußmittel benetzte Seite der Leiterplatte hindurchbewegt wird, dadurch **gekennzeichnet**, daß in der Nähe der voreilenden Überlaufkante der Düse 2 bezüglich der Transportrichtung eine einstellbare Stauereinrichtung (7,12,27) angeordnet ist, die einen im Querschnitt U-förmigen Kanal (7), der senkrecht zur Transportrichtung angeordnet ist und Kanten parallel zu den Überlaufkanten der Düse (2) aufweist, und Pumpeinrichtungen (12, 27) umfaßt, um vorübergehend den Pegel des geschmolzenen Lotes nach oben aus dem Kanal (7) heraus anzuheben, derart, daß der Kamm des Schwall von oberhalb der Düse in Richtung auf die voreilende Kante verschoben wird.

2. Vorrichtung nach Anspruch 1, dadurch **gekennzeichnet**, daß der Kanal (7) an der Außenseite der Düse (2) angeordnet ist.

3. Vorrichtung nach Anspruch 2, dadurch **gekennzeichnet**, daß der Kanal in seiner Höhe bezüglich der Düse einstellbar ist.

4. Vorrichtung nach einem der Ansprüche 1 bis 3, dadurch **gekennzeichnet**, daß der Kanal im Querschnitt die Form eines Teils eines Kreises aufweist, und daß die Pumpeinrichtung ein Walzenkörper (2) ist, der drehbar in Längsrichtung des Kanals (7) gela-

gert und angetrieben ist und einen unrunder Querschnitt aufweist.

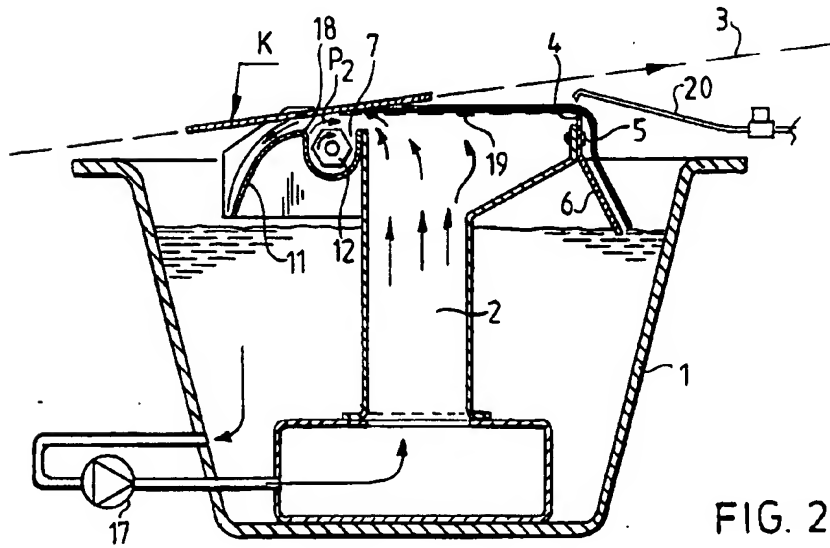
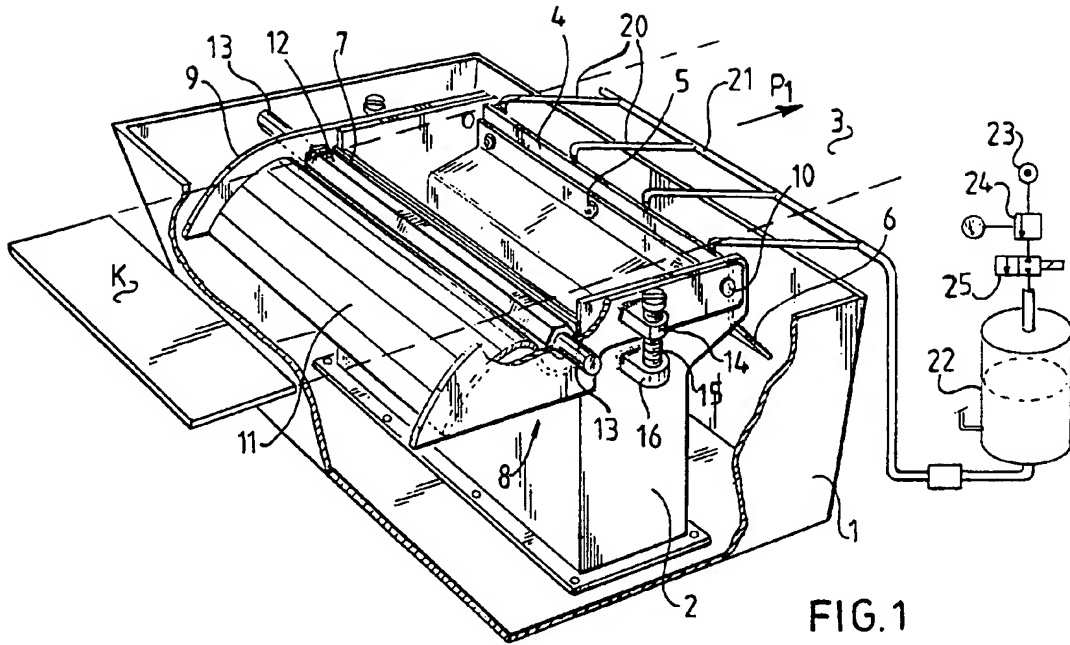
5. Vorrichtung nach Anspruch 4, dadurch **gekennzeichnet**, daß der Querschnitt ein Sechseck ist.

6. Vorrichtung nach Anspruch 4, dadurch **gekennzeichnet**, daß der Querschnitt ein Exzenter ist.

7. Vorrichtung nach einem der vorhergehenden Ansprüche, bei der eine Einrichtung zur Zufuhr eines isolierenden Flüssigkeitsmaterials auf die Schwalloberfläche vorgesehen ist, dadurch **gekennzeichnet**, daß ein oder mehrere Düsenstücke (20) mit den Zufuhreinrichtungen verbunden sind, um das Material örtlich auf der Oberfläche abzuscheiden.

8. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch **gekennzeichnet**, daß oberhalb des Kanals eine perforierte Führungsplatte (30) angeordnet ist.

9. Vorrichtung nach Anspruch 8, dadurch **gekennzeichnet**, daß die Platte mit einer Verlängerung (31) versehen ist, die in die hohle Düse reicht.



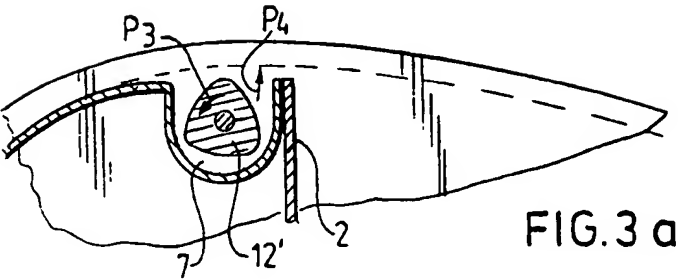


FIG. 3 a

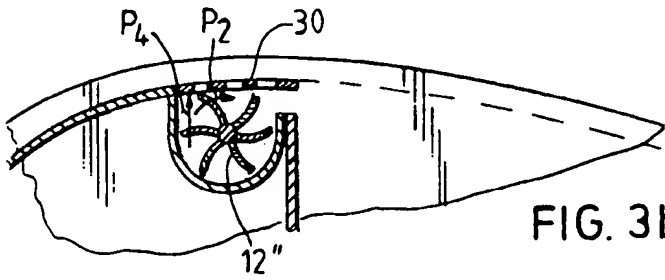


FIG. 3b

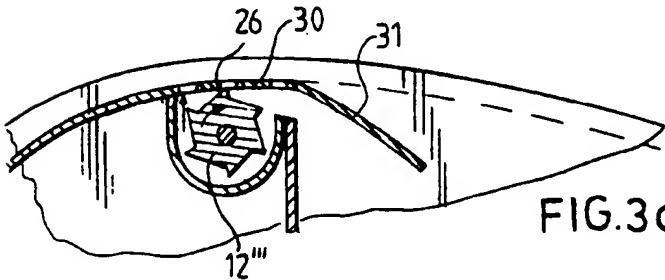


FIG. 3c

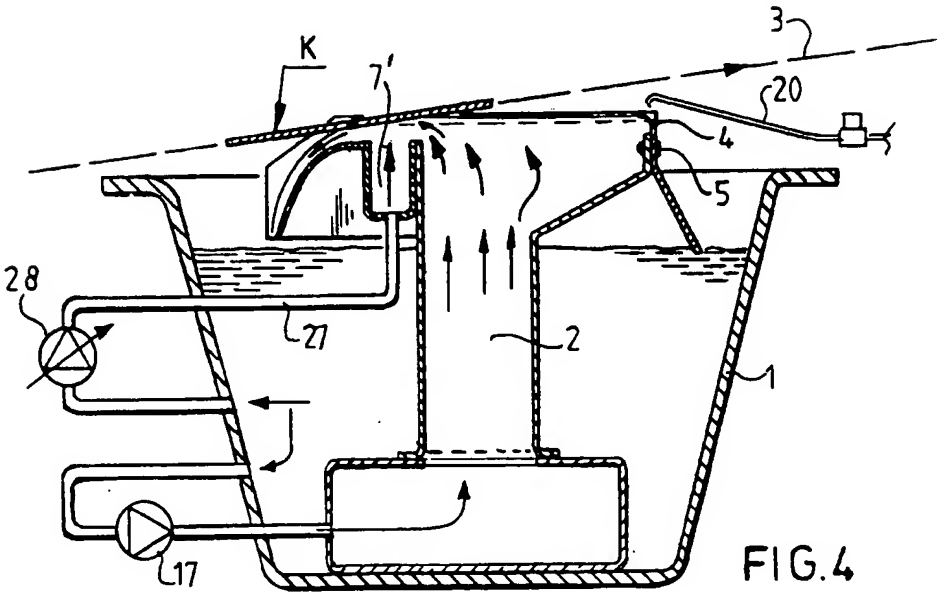


FIG. 4